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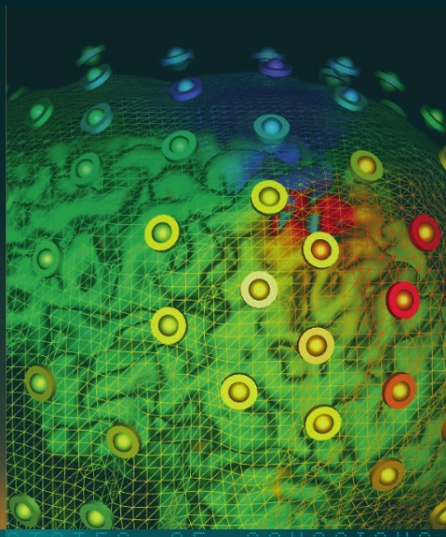

Dean Cvetkovic
Irena Cosic (Eds.)

STATES OF CONSCIOUSNESS

Experimental Insights into Meditation, Waking, Sleep and Dreams

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Editors

States of Consciousness

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Dedicated to my partner and family for endless love, inspiration and support.
Dedicated to everyone who is searching to explain that elusive conscious experience that has once left a memorable mark in our lives, changed us and continues to do so. . .

Dean Cvetkovic

Preface

A search for a deeper understanding and exploration of consciousness has long been and still is widely studied by scientists and philosophers alike. There are countless examples of individuals making significant changes to their lives in following a brief encounter with state of consciousness. Naturally, a philosopher would want to define this state of consciousness and a scientist would want to measure it. Both philosophers and scientists have the common goal of wanting to explain consciousness. Whether philosophical and scientific approaches will succeed in capturing this elusive "thing" that we so often refer to as consciousness remains to be seen.

The first few chapters present introductory theory and insights into various states and disorders of consciousness. In the opening chapter, I introduce consciousness, its history, various philosophical and scientific theories, contemporary technological advances, natural medical phenomena, solid experimental findings that reveal correlations between physiological processes and consciousness, and finally an overview of the following chapters. Other chapters present various psychophysiological, neurocognitive, neuroscientific and neurobiological theories and models of waking, sleeping, dreaming and meditation, tested with advanced neuroimaging and engineering biomarkers. These chapters highlight the need to utilise the knowledge of consciousness in order to develop corrective treatments for certain disorders and pathological problems of consciousness. The remaining chapters describe the more specific altered states of consciousness, such as hypnagogic phenomena and transcendental meditation, which are generated both internally, within the human body, and externally, as environmental stimuli.

While the main states of consciousness are considered to be wakefulness, sleep and dreaming, there are multiple specific states that originate across these three states and along its borders. Altered states of consciousness are dynamic transitional processes, where a subject continually enters a new state and leaves the old state. One may become aware of these altered states of consciousness where one's own conscious experiences and perception are characterised by electrophysiological, cognitive and behavioural changes.

The book is not aiming to define or, identify all possible states of consciousness, nor is it claiming to present exact ways to measure the level of these states of consciousness. On the contrary, the idea of writing and compiling this book

emerged from my long fascination with certain intricacies of the phenomenon of consciousness. Whether these intricacies can be identified as states, contents, properties, levels or processes of consciousness is debatable. But what remains important is that they exist and are classified as either normal or disordered consciousness. The invited chapters are meant to serve both as a basic introduction and an in-depth research on some well-known and rare states of consciousness.

We hope that this book will provide inspiration to people from all walks of life, from professionals to students at all levels of education. We also hope that the book will encourage readers to explore certain aspects of consciousness using scientific approaches in order to gain insight in own conscious experiences.

Melbourne, Australia Dean Cvetkovic
June 2011

Contents

Chapter 1
Introduction to States of Consciousness

Dean Cvetkovic

Abstract The problem of consciousness is mostly regarded as identical to the mind-body problem. According to Chalmers' philosophical arguments, the hard problem of consciousness lies in establishing and explaining the link between physical processes and conscious experiences, via psychological processes. A brief history of various theories of consciousness is given and a selection of theories are tested against Zeman's three fundamental intuitions and Chalmers' controversial zombie argument. The hard problem of consciousness is further described using Levine's notion of an explanatory gap between physical matter and conscious experience, through the first and third persons. Various states, contents, levels and processes of consciousness are summarised, including Damasio and Meyer's dual perspective for defining consciousness. Tart's three definitions do not entirely describe altered states of consciousness. While the challenge of finding the core function of human and animal sleep remains unknown when tested under the null hypothesis, studies on the neural correlates of consciousness during meditation have revealed neuroplasticity effects. The synchrony of gamma brain oscillations reflecting various styles of meditation or attention, also known as the binding problem, may be related to conscious experiences. This binding problem with gamma brain oscillatory synchronization also arises in relation to sensory awareness or perception, affecting the perception of time and hallucinatory experiences in various disorders of consciousness such as severe schizophrenic and déjà vu (in healthy or epileptic) patients. In conjunction with medication treatments, music therapy is often useful in accelerating the healing process in most such disorders of consciousness. It is still unknown how this sensory awareness to music is perceived in medicated patients suffering from disorders of consciousness. More clinically elusive are near death experiences, in which consciousness persists independently of brain function, where there is no scientific basis for such consciousness to exist and no physiological or psychological model that can explain it. Near death

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experiences can be regarded as a special state of consciousness, which provides further evidence that the consciousness problem may be very close to the mind-body problem that originates in Descartes' classic theory of dualism and is transformed into Chalmers' contemporary theory of natural dualism. The final section of this chapter offers an overview of all invited chapters.

> I know my processes are just electronic circuits, but how does this explain my experience of thought and perception? (Hofstadter 1985, p. 186)

1.1 Psychological and Phenomenal Consciousness

The best way we can get closely acquainted with consciousness is to experience it using all our senses, thoughts, feelings, emotions and perceptions. The subjective experience is so strong in shaping a human character that we refer to it as human psychology. When we think of psychology we often ignore physiology, and this fact reminds us that consciousness may relate to the mind-body problem. Memory is very powerful, yet it is different for everyone. Memories can retain information from all the senses that we know to exist. Our senses of smell, taste, touch, hearing and vision can all translate our environmental experiences into information that is stored in our memory. These experiences may be visual, auditory, tactile or olfactory, or relate to taste, temperature, pain, other body sensations (orgasms, itches, etc.), mental imagery, conscious thoughts, emotions or the sense of self ("I"). How does the brain maintain a sense of self? While conscious experiences generate new neural pathways, by constant wiring and rewiring, the self-image or understanding of "I" remains elusive. However, we do understand that the "I" can act as a reference point for ordering our thoughts, emotions and experiences, and it can create boundaries between internal and external events to form experiences. If these experiences were pleasant when they were first sensed (e.g. hearing a popular song while walking along the beach in one's early childhood) and later the same sensations occur (e.g. years later the same song is heard), the sense is triggered, information is extracted from memory and the experiences are relived, so that mental states or emotions are induced and physical actions may be realised (e.g. by dancing). In extreme cases, these experiences may be peak experiences, or "sudden ecstatic moments of great happiness, awe, and of a feeling of unity that gives way to serenity and contemplation" (Maslow 1971, p. 235). Even the wistful memories of the smell of mother's cooked pancakes can induce a yearning for the past, resulting in experiences of nostalgia. It was only recently revealed that such nostalgic experiences can elevate moods, increase self-esteem and improve our overall well-being. Indeed, "like armour shielding the mind from dark thoughts, nostalgia protects against psychological onslaughts in the future" (Gebauer and Sedikides 2010, p. 35).

While the mind can easily differentiate the information coming from the various sensory modalities (vision, hearing, taste etc.), the mind finds it challenging to

distinguish emotions, memories, feelings and thoughts from each other (Peat 1987). If a person feels sad or happy, he/she may not be able to find the main cause of that reaction. The main cause may be not the external sensory information that triggered the state, but an internal feeling initiated by a thought or by fragmentary memories leading to the creation of a series of inner thoughts. Such external and internal mental processes can often result in an inability from a first-person or a third-person perspective to recognise or distinguish the causes. Why am I feeling this way all of a sudden? The phenomenal state of mind is the conscious experience. The psychological state of mind is the explanatory basis of behaviour, and is studied in cognitive science. The phenomenal state is characterised by the way it feels (or how it feels) and the psychological state is characterised by what it does. Chalmers suggested that for every phenomenal state there may also be a psychological state and that one cannot be differentiated from the other. Both states are part of the mental concept, which may be described as having a double life.

Scientific methods have difficulty in observing the phenomenon of consciousness. David Chalmers suggests that the problem of consciousness lies on the border between philosophy and science and that if one is to study this problem scientifically, one must also understand the philosophy and vice versa. Chalmers distinguishes the "easy" and "hard" problems of consciousness (Chalmers 1996). While most easy problems still continue to challenge us scientifically, the philosophical and scientific aspects of the hard problem remain untouched. The easy problems mainly deal with the neural correlates of consciousness and the *how* question (i.e. the physiological processes in the brain and how psychological processes respond under the influence of internal or external sensory stimuli). By contrast, the hard problem is concerned with the question of why these physiological and psychological processes live a double life as experiences.

Chalmers also addressed the mind-body problem when he distinguished easy and hard problems. The hardest problem is this: "how could a physical system give rise to conscious experience?" (Chalmers 1996, p. 25). Chalmers argues that the relation between the physical process and the conscious (phenomenal) experience depends on the dual link between the physical and psychological, and psychological and phenomenal. It is well understood that there is a link at the level of how physical processes can have psychological properties. However, it remains unknown "why and how these psychological properties are accompanied by phenomenal properties" and "understanding the link between psychological and the phenomenal is crucial to understand conscious experience" (Chalmers 1996, p. 25). Pain is a good example to illustrate how we distinguish phenomenal from psychological mental concepts. Pain experience cannot be measured objectively, but subjectively it can be rated (e.g. by the level of unpleasant phenomenal quality). Pain also causes a psychological effect when the person suffering it assumes that this unpleasantness is generated by an injury or damage to the organism, which then leads to other reactions.

An example of a dual mental concept is that of perception, which can be considered to be psychological or phenomenal, or to combine both components. The psychological component of perception concept is processed in the cognitive

system, influenced by environmental stimulation. By contrast, the phenomenal perception consists of the perceived conscious experience. The sensation can be regarded as the phenomenal component and the perception as the psychological component. But the concepts of perception and sensation can lean towards each other or blur together. Sensation is regarded a state responsible for feeling. This makes it impossible to objectively or even subjectively measure the experience of colour sensation. It is believed from both scientific and personal exploration (via physics, biology, neuroscience and social and cultural studies) that we can consciously experience colour. The conscious experience of any colour needs to be understood first in the very same social and cultural environment that we live in, through perceptual learning. Karl H. Pribram, psychologist and psychiatrist, presented an example of how some cultures perceive and experience some colours differently to other cultures (Pribram 2004). For example, people in the northern national state XYZ (where "XYZ" is used to preserve anonymity) were unable to distinguish red from green, or red from yellow or black, mainly because the colour red was rarely experienced in their environment. But the people of XYZ were able to distinguish many shades of green. People of other cultures working in XYZ at the time were unable to distinguish these shades of green.

Pribram states that conscious experiences are "initially emergent from brain processes produced by input generated by the brain's control over its physiological, physical, chemical, and socio-cultural environment. When changes occur in that environment, changes are produced in the brain processes. Only when these peripheral changes become implemented in the brain's memory do the resulting experiences become accessible to further processing" (Pribram 2004, p. 24).

1.2 History, Philosophy and Theories of Consciousness

There are many philosophical theories of consciousness, such as: dualism, behaviourism, idealism, functionalism, identity (personal), phenomenalism, phenomenology, emergentism, mysticism, externalism, physicalism and others. Only a few of these widely known theories are described in this chapter.

Mind-body dualism was formally introduced in modern philosophy by René Descartes (1596–1650), through the statement *Cogito ergo sum* ("I think therefore I am"). Descartes did not distinguish consciousness from the mind-body nexus. He defined body as extended physical material (space-filling) and mind as unextended (did not take up space) non-physical *Res cogitans* ("thinking thing"). Dualism dwells in both physical and non-physical worlds. Cartesian dualism sought to explain how an independent mental substance can influence physical processes, which gave meaning to the familiar idea of mind over matter. A contemporary philosophical perspective by John Searle is that dualism is wrong and that only changes in the brain state can create conscious states (Searle 1992). Bishop George Berkeley (1685–1753) was another philosopher of consciousness, an *idealist* who attempted to show that we only experience percepts, thoughts and feelings and that

an external world (explained by physics) is imagination and illusion. This philosophical theory was never finally discredited. William James (1842–1910) defined his own philosophical theory of mind, known as *functionalism*. Functionalist theory explains that a mental state does not depend on any physical internal properties but on the way it functions or the role it plays in the system (mind). In 1890, from that theory of mind, James introduced the stream of consciousness as a process, stream or a flow of thoughts of which one is aware (James 1890). He described four major characteristics of this stream of consciousness: every thought belongs to some personal consciousness; consciousness is in the constant change; personal consciousness is continuous and like a stream, flowing from one place to another; and the stream flows towards one particular place that brings stability to the constant change of thought and feeling (Kokoszka 2007).

Pioneering psychologists Sigmund Freud (1856–1939) and Carl Gustav Jung (1875–1961) theorised that consciousness has three levels or categories, respectively. Sigmund Freud contributed immensely to the study of consciousness and altered states of consciousness (ASC) by identifying three levels of consciousness: the conscious level (awareness of oneself and one's environment); the subconscious level (where information remains hidden from consciousness until it presents itself over time or with therapy); and the unconscious level (where information is blocked from consciousness and is extremely difficult to access, requiring years of therapy, but may be accessed through dreams and dream interpretation). To access the subconscious and unconscious levels, Freud proposed psychoanalysis and dream content analysis (where dream symbols represent conscious experiences), respectively. Conscious experiences can be observed and communicated with others, but the unconscious processes are difficult to access. Sigmund Freud devoted his life to developing a technique that was able to bring these unconscious processes up to the level of consciousness, where they could be shared and treated in therapy. Freud believed that there is a subconscious mind and there are unconscious beliefs and desires that can trigger certain related behaviours. Modern hypnosis or self-hypnosis therapies are used to "correct" such unconscious desires, through voluntary relaxation and auto-suggestive techniques.

Jung developed his own theory of mind and of natural and altered states of consciousness, extending on Freud's theory of unconsciousness. Jung identified three categories of consciousness: personal consciousness (conscious awareness at one point of time); the personal unconscious (memories at the edge of conscious recall, similar to Freudian repressed memories); and the collective unconscious (universal human reactions based on pre-existing forms known as archetypes that influence individual experience). Jung believed that there is a strong directional link from unconscious to consciousness. The unconscious acts as a memory organizer and feeds the relevant information to consciousness whenever is needed.

These advances in psychology (rather than in philosophy) set the psychological and phenomenal concepts of mind apart. Behaviourist psychologists ignored the phenomenal concept and highlighted the psychological concept. Some behaviourists denied that consciousness had anything to do with psychology and even denied that consciousness existed. From the 1940s, there was a shift from the

phenomenal to the psychological concept of mind, mainly in the work of Gilbert Ryle (1900–1976), who believed that mental states can be analysed in terms of certain behaviour. In the 1960s, mental concepts began to be analysed functionally, by investigating the interaction of mental states and their causes and effects.

For Adam Zeman, any theory of consciousness must obey three fundamental "intuitions" (as he calls them) (1) consciousness is a robust phenomenon which deserves to be explained rather than being explained away; (2) consciousness is bound up with our physical being; (3) consciousness makes a difference (Zeman 2001, p. 1282). Each of the three theories of consciousness – dualism, identity and functionalism – clashes with at least one of these intuitions.

Chalmers has proposed naturalistic property dualism. This theory has some but not all aspects of dualist theory. Chalmers does not assume that there is a mental substance or "thinking thing" but builds on fundamental laws aligned with modern scientific results. He accepts that these fundamental laws are unknown and may be incomprehensible to humans, but says they are still naturalistic. In modern science, where physical theory states that "for every physical event, there is a physical sufficient cause" (Chalmers 1996, p. 125), the elements of religion, spiritualism or supernaturalism are considered nonscientific and those elements should not be associated with dualism.

Since experiences or other elements may appear as phenomenal properties of consciousness, they may be correlated with physical properties to establish dualism. The fundamental laws of consciousness may be psychophysiological laws that specify the dependency of phenomenal properties on physical properties. Chalmers expressed this by saying that while physical theory "gives a theory of physical processes", psychophysiological theory "tells us how those processes give rise to experiences" (Chalmers 1996, p. 128). Chalmers concluded that "once we have a fundamental theory of consciousness to accompany a fundamental theory in physics, we may truly have a theory of everything" (Chalmers 1996, p. 127). Responding to Chalmers' explanation of his natural dualism, Zeman concluded that he tends "to be driven to the conclusion that conscious experience is a beautiful but functionally irrelevant embellishment of physical processes" (Zeman 2001, p. 1284). For Zeman, dualism fails his third intuition that consciousness makes a difference.

An identity theory was introduced by experimental psychologist Edwin G. Boring (1886–1968) in 1933. The corresponding philosophical theory of mind was formally established in the 1950s by Ullin T. Place and Herbert Feigl. Place and Feigl claimed that mental states and processes are the same as states and processes of the brain. For example, the identity theory treats the experience of hearing a melody or seeing a baby blue colour as identical with brain processes and not as mere correlates of brain processes. Behaviouristic, materialistic, physicalistic and reductionist approaches have been applied to explain the identity theory of mind. Testing the identity theory against his intuitions, Zeman infers that its main implication is that conscious events originate in the brain and have a functional role for behaviour, which fails to satisfy his first intuition that "the properties of experience are robust phenomena in need of explanation" (Zeman 2001, p. 1283).

He concludes that conscious experiences cannot be reduced to the neural structures and processes on which they depend.

Functionalism is another philosophy of mind which explains that a mental state does not depend on the physical internal properties but on the way it functions or the role it plays in the system (mind). Based on this functionalist theory, Daniel Dennett proposed two cognitive models of consciousness. He called the first one a box-and-lines model (Dennett 1978) by analogy with an engineering functional block diagram that can be used to explain the functionality of a system. In Dennett's case, the system is the mind, which consists of a flow of information (lines) between modules (boxes). The modules are a perceptual unit, a short-term memory store, control systems and a "public relations" module. This model may explain our ability to report the contents of our internal states and to control our behaviour using our perceptual information. Dennett called the second model a "pandemonium" model, since it consists of multiple cognitive agents (demons) that compete to control mental processing (Dennett 1991). Instead of the main control module, this model includes multiple channels forming a highly parallel information system. This model has been adapted for applications in neuroscience, artificial intelligence, etc. Dennett's model may be applied in artificial intelligence to model how visual experiences arise from countless acts of discrimination and classification. The advantages of these cognitive models are that they focus on attention, explain reportability and show the influence of information on control of behaviour. However, most of these cognitive models, as Chalmers argues, basically ignore the hard problem of consciousness, of "why should there be conscious experience in the vicinity of these capacities" (Chalmers 1996, p. 114). In other words, they fail to explain the role of phenomenal consciousness in describing how our minds generate the conscious experience that we enjoy. As Zeman says, "Why should consciousness be like this?" (Zeman 2001, p. 1283). Dennett's models explain our human ability to report verbally on our mental states while ignoring their physical neural properties. The cognitive models can be applied to describe psychological consciousness, but the functionalist theory of mind fails to explain phenomenal consciousness. They fail to meet Zeman's intuition that consciousness deserves not to be explained away.

Considering that science and philosophy strive to explain everything in physical terms, there is a tendency to explain consciousness in a similar way. A thought experiment called the zombie argument shows where physicalists and dualists have different views. Chalmers, a natural dualist, proposed the concepts of a zombie and a zombie world, where a zombie is defined to be someone or something that is physically identical to a conscious being, like "me", but has no conscious experience. The zombie world is a world where people are all zombies but is otherwise identical to ours. A zombie lacks only conscious experience. Chalmers called an unconscious clone a zombie twin and explained that our zombie twin is psychologically and physically identical to us. This zombie can have enough function to perceive any external information, have psychological senses, be awake, report the contents of internal states, and maintain focused attention towards an external environment. As Chalmers says, "none of this functioning will be accompanied

by any real conscious experience. There will be no phenomenal feel. There is nothing it is like to be a zombie." (Chalmers 1996, p. 95).

Physicalists often criticise this Chalmers zombie argument, claiming that it is not possible and believe that zombies are organisms that may have consciousness but not in the reality. Dennett, disagrees with Chalmers on this zombie argument, stating that pain, for example, cannot be replicated from a human mental state, without considering its behavioural or physiological differences. Chalmers on the other hand, believes that even though zombies are probably not naturally existent with the current laws of nature, zombie scenario is logically possible. Chalmers also claims that the brain physiology despite its complexity, cannot "conceptually entail consciousness" (Chalmers 1996, p. 98). Despite its controversy and different views in the philosophical community about the zombie argument, conscious experiences may still be challenging to explain.

1.3 Problems of Consciousness

In defining consciousness, the neuroscientists Antonio Damasio and Kasper Meyer (2009) identified a dual perspective (which is not a dualist theory). One perspective is internal and first-person (subjective, cognitive and mental) and the other perspective is external and third-person (behavioural, that of an objective observer). Lutz and Thompson contrasted these two perspectives by noting that first-person subjective reports are problematic and often biased and inaccurate (Lutz and Thompson 2003). In the early 1980s, Levine (1983) introduced the notion of an explanatory gap between conscious experience and its physical substrate, between the respective first-person (subjective experience) and third-person (body and behaviour) reports. Bridging this explanatory gap could help to solve the problem of consciousness. Varela (1996, 1999) proposed to bridge the gap through research in neurophenomenology that would develop towards the study of consciousness. The main aim of neurophenomenology is to generate and refine first-person data by means of a phenomenological exploration experience in order to interpret and quantify the physiological and behavioural processes that are relevant to consciousness. This explanatory gap is not supposed to be a different problem to Chalmers' (1996, p. 25) hard problem of consciousness, that of how a physical system could give rise to conscious experience, but a "methodological substitute" for the hard problem. The methodological problem is "how to relate first-person phenomenological accounts of experience to third-person cognitive-neuroscientific accounts" (Lutz and Thompson 2003, p. 47). The notion of an explanatory gap is not intended to address the hard problem, nor is anyone claiming to have bridged the gap. It provides only a pathway for scientific research. The reason for proposing this pathway is to bridge the related gap between the areas of neuroscience (third person) and psychology and philosophy (first person). Lutz has suggested that this neurophenomenological approach may complement current behavioural and cognitive research in areas such as: brain plasticity of human experience; time

consciousness (Varela 1999); lucid dreaming; etc. Lutz also distinguished a number of kinds of consciousness (e.g. creature consciousness, background/state consciousness, transitive/intransitive consciousness, access consciousness, phenomenal consciousness, introspective consciousness, and pre-reflective self-consciousness), some of which are debatable and controversial (Lutz and Thompson 2003, p. 34–35).

A world renowned neuroscientist, E. Roy John (1924–2009) summarised the problem of consciousness thus: "perceptual awareness involves the integration of distributed synchronous activity representing fragments of sensation into unified global perception. How this statistical information is transformed into a personal subjective experience is the problem of consciousness." (John 2002, p. 3).

1.4 States, Contents, Levels and Processes of Consciousness

Karl H. Pribram, psychologist and psychiatrist, identified three modes of conscious experience: states, contents and processes. Conscious states are influenced by the biochemical and biophysical substrates of wakefulness, sleep and dreaming. Conscious contents are better known under perception. Conscious processing binds state with perceived content and content with state.

Steven Laureys, a neurologist, has defined consciousness clinically as having two main components: *awareness* of self and environment (content of consciousness) and *arousal* (alertness or vigilance) or wakefulness (level of consciousness) (Laureys and Tononi 2009). Awareness refers to conscious perception and consists of cognition, intentions, experiences stored in memory (from the past) and the present. Awareness of self is a mental process entangled in the socio-cultural environment but not necessarily dependent on or influenced by external stimuli. Awareness of the environment, on the other hand, is conscious perception of the environment through the sensory modalities. The functionality of consciousness is unknown and it is also unknown if it exists in the first place. Modern cognitive science has so far addressed sensation, perception, attention, and emotion. But psychiatrist and dream researcher John A. Hobson says it does not address the details in "characterizing each aspect of mentation (i.e. the process or result of mental activity)" (Hobson 2009, p. ix).

Chalmers identified psychological consciousness as consisting of: *awareness* (our ability to process information about the world and deal with it in rational fashion), *introspection* (the process by which we can become aware of the contents of our internal states), *reportability* (our ability to report the contents of our mental states), *self-consciousness* (our ability to think about ourselves or our awareness of our existence as individuals and of our distinctness from others, which is limited to humans and few animal species), *attention*, *voluntary control* and *knowledge* (Chalmers 1996, p. 26). Our awareness is accompanied by phenomenal consciousness, which is often unintentionally ignored because psychological consciousness gets all the attention.

Damasio and Meyer, with their dual perspective, identified the external perspective as the signs of human consciousness in wakefulness, background emotion, attention and purposeful behaviour. The background emotion, which differs from normal or primal emotion (e.g. anger, fear, sadness, joy and happiness) and social emotions (our "de facto moral compass" (Goleman 2007, p. 131), including embarrassment, compassion and guilt), can be expressed and observed (by an external observer) from body language (body posture, movement etc.). Interestingly, it was recently discovered that guilt dwells in the front and back cingulum of the cerebral cortex. Attention directed towards a mental object and events is evidence of the presence of consciousness. These mental objects and events can be external (e.g. phone ringing and your name being called) or internal (i.e. thoughts). In cases of schizophrenia, these perceived internal objects and events are distorted by hallucinatory internal voices, which is why consciousness experience in schizophrenic people is not considered as normal but might be seen as partly reflective behaviour. In all, Damasio summarised the external perspective by linking thoughts, emotion and behaviour: "conscious human behaviour exhibits a continuity of emotions induced by a continuity of thoughts" (Damasio and Meyer 2009, p. 5). Damasio's internal perspective can be identified as the human conscious mental state when it represents objects and events in relation to itself. In that case, the person is a "perceiving agent" (Damasio and Meyer 2009, p. 6) who is "generating the appearance of an owner and observer of the mind, within that very same mind" (Damasio and Meyer 2009, p. 5; Damasio 1999/2000). The mental events are created from a series or scenario of mental images which are generated by neural activity and integrated via sensory modalities in space and time. However, there are unknowns in how humans or animals perceive time linked to these internal conscious events.

Is it possible for anyone to consciously experience both the external and internal (dual) perspectives within themselves? Or are we able only to experience one of the perspectives at a time? Damasio defined consciousness as a "momentary creation of neural patterns which describe a relation between the organism, on the one hand, and an object or event, on the other" and extended the definition by adding that "the creation of self neural patterns is accompanied by characteristic observable behaviours" (Damasio and Meyer 2009, p. 6). The central problem in the study of consciousness is the self state: the sense of self ("I"), subjectivity and its subjective process.

According to Damasio, consciousness can be divided into two kinds, *core* consciousness and *extended* consciousness. Core consciousness is a simpler kind of consciousness, which "establishes the relationship between an object and the organism" (Damasio and Meyer 2009, p. 12). Extended consciousness is a more complex kind of consciousness, which "enriches the relationship by creating additional links between the object and the organism, not just with respect to the presence of the latter in the here and now, but also to its past and anticipated future" (Damasio and Meyer 2009, p. 12). Extended consciousness depends on core consciousness. It consists of multi-level mental information processing, depends on memory and is enhanced by language, which represent the contents or perception.

By contrast, core consciousness is independent of memory or language. Core consciousness depends on the neural activity generated in the brain mainly during wakefulness. The neurobiology of core consciousness "requires the discovery of a composite neural map which brings together in time the pattern for the object, the pattern for the organism, and establishes the relationship between the two" (Damasio and Meyer 2009, p. 8; Damasio 1999/2000). Damasio hypothesises that both extended and core consciousness dwell in the posteromedial cortex and in thalamocortical interaction (Llinas and Ribary 1993).

1.5 Altered State of Consciousness

The waking state of consciousness is typically experienced by our central nervous system responses to external stimuli, which are sensed by our sensory modalities (i.e. smell, taste, touch, hearing, vision). This waking state of consciousness relies on the way these stimuli interact with our mind and body. However, if the level of stimulus is increased or decreased so as to affect the internal responses and cause us to feel or sense the change, we know we are not in a "normal" waking state of consciousness, but in an altered state of consciousness (ASC), which may be defined as "a qualitative alteration in the overall pattern of mental functioning such that the experiencer feels his [or her] consciousness is radically different from the 'normal' way it functions" (Tart 1972, p. 1203).

Over the years, the ASC has been defined in a number of ways: as a "changed pattern of subjective experiences" (Kihlstrom 1997); or a "reflective awareness of changed pattern of subjective experiences" (Tart 1972); or a "changed pattern of subjective experiences and physiological responses" (Shapiro 1977). Tart pointed out that the three definitions do not entirely describe altered states. The first definition relies on subjective experiences and is insufficient. The second definition requires one to be aware of what is normal or altered in subjective experience, and most of the time this distinction between the normal or altered may not be clear. What is a normal experience? The third definition may give rise to problems in defining the exact neural correlates and mechanisms that may influence (or be influenced by) the subjective experiences. But it can at least assist in measuring what is normal and what is altered experience. This is where contemporary science is continuing to make progress in consciousness studies.

Tart attempted to identify mind through awareness and consciousness components (Tart 1975). Consciousness encompasses awareness in the complexity of our mind. Assigning a precise logical definition to all three keywords (consciousness, awareness and mind) may never be possible, because, as Tart explained, logic is only one component or product of the functioning of the whole mind, and this one part may not define the whole mind. For example, to describe awareness and consciousness, Tart considers the perception of sound to describe awareness and complexity to recognise that sound and identify the instrument or object that generated it.

The level of stimulus can influence the ASC, by the reduction of sensory input (meditation or isolation) or increase of sensory input through repetitive stimulation (chanting, drumming, dancing, etc.), sensory overload (e.g. dancing, music, lights, crowd or a combination of all of these), or various mental and emotional states. (Ludwig 1969). There are other stimulus factors which may also influence the ASC, but they do not depend on the sensory systems. These other stimulus factors contribute to alteration of body biochemistry or neurophysiology through sleep deprivation, stress, mental burn-out, fasting, physical and mental exercise, substance intake (e.g. drug abuse) and others. Trying to re-create an ASC whenever we wish may require years to master (e.g. via meditation and yoga) and it can lead to healthy or unhealthy lifestyles. The only time we may experience an ASC is by noticing the difference while experiencing a waking state of consciousness. The key to noticing these differences between waking and altered states of consciousness is through self-awareness. Even this self-awareness can be influenced by perception (so that it is not what it seems) and distorted by many psychophysiological and psychotic disorders (e.g. schizophrenia, a distortion of reality characterised by hearing voices and seeing unreal images).

For Dietrich, "any modification of information processing, from the sensory level to the prefrontal cortex, alters the content of consciousness" (Dietrich 2003, p. 237). Dietrich proposed that to induce each altered state of consciousness, a particular behavioural technique would need to be utilized. Inducing an ASC would generally decrease the activity in the prefrontal cortex or cause prefrontal cortex deregulation or transient hypofrontality, and in turn produce minor changes in the contents of consciousness. Such ASCs as dreaming, daydreaming, meditation, hypnosis, "runner's high" (endurance or marathon running experience) and drug-induced states, all have a cognitive aspect that is controlled by deregulation of the prefrontal cortex. It is not just the prefrontal cortex or neural structure that is necessary for consciousness. There are functional neuroanatomical layers that are responsible for an ASC. If one neural layer (according to Dietrich's model) were damaged, then it would alter a particular state of consciousness.

Recent research indicates that romantic rejection and similar psychological pain can alter the heart rhythm. This romantic rejection can be traumatic: the feeling of being rejected can slow the heart rate and even stop the heart momentarily. It has been suggested that some brain regions are origins for processing the physical and emotional pain and that the pain affects the autonomic nervous system. What is more important is that this incident can trigger depression in some predisposed people. Others may have post-experience of an ASC by having precognitive dreams, strong intuitive feelings, etc. However, it not known why such ASCs occur during these post-traumatic periods. Conceivably, they "heal" the pain of rejection by providing "hope" to a person that he or she will be fine and perhaps reconnect with their loved one or find another romance. Perhaps it is simply a distorted physiological effect that triggers this ASC. If a human body is capable of self-sufficient healing at the molecular level (as living cells continually die and new cells replace them), is there a psychological and phenomenological process or mechanism to heal a broken heart from the trauma of romantic rejection?

Drowsiness is a transition between the waking state and the sleep state. It may not necessarily involve turning one state off or on to make room for the other state. The waking state may drift in and out of an early sleep stage a couple of times, creating the state or process of drowsiness. But how does that process translate to how one would feel during that transition? For example, an experienced professional truck driver can fall asleep momentarily while driving and let go of the steering wheel, causing the truck to steer off the road and crash. It is understood that when a driver falls asleep, the muscle tone decreases, the eyelids close, the jaw and neck muscles relax, and the hands loosen their grip on the steering wheel. However, what is difficult to comprehend is that the same driver would be aware of falling asleep and loosening his or her grip on the steering wheel and yet continue to drift further into the state of drowsiness. In that state of deep drowsiness, one would have an momentary feeling that nothing is important and let go of the conscious control that is present only during wakefulness. In reality, the truck driver would normally be trying to make a freight delivery on time and that background state of stress would be sufficient to ensure alertness and keep the driver awake while driving. But the pleasant sensation accompanying the attitude that nothing matters while drifting from wakefulness to sleep (a transition from one state of consciousness to another) becomes the primary working mode instead of responsible driving. Often, a sleep debt or tiredness may help to make a driver fall asleep, but in other circumstances, it may only be boredom in traffic that stops the brain from staying alert. The details are irrelevant here. What is important is the power of transitional consciousness and state switching to control our lives and change our behaviour.

While sleep debt, tiredness and traffic boredom can cause a driver to slip in and out of and the waking-sleeping transition, a daydreaming ASC might be working in the background mode and the same driver may not be aware of it while driving. That driver would eventually arrive at the destination after few hours, navigating through traffic, and would not be able to recall how he or she consciously drove all that time. This experience of what may be an ASC proves that the awareness and processing of external sensory information does not decrease but is on the contrary increased when the driver's mind wanders elsewhere. It is not yet known whether these simultaneous state-switching operations (i.e. conscious driving while navigating through traffic, slow drifting to sleep and daydreaming) are generated by the same or different cortex layers or how these layers interact with each other. We do not know which cognitive function and neural mechanism decides when and whether an ASC works in the primary working mode or background mode.

1.6 Human and Animal Sleep

Wakefulness and sleep are equally fascinating states of consciousness, especially the unique ASC, known as sleep onset, the hypnagogic state or the "wake to sleep" transition (the author describes this scientific research in more detail in Chap. 7). Sleep research pioneer Nathaniel Kleitman (1895–1999) claimed that conscious

experiences are different while awake and asleep. In fact, one can be conscious while asleep and unconscious while awake. This observation may contradict the general understanding that one is not conscious while asleep, because the dream experiences can tap into the unconscious states. Sleepwalking is a sleep disorder, which occurs during deep stages of sleep (low consciousness) when one is consciously active (walking, talking, etc.) much like when awake. René Descartes was fascinated with philosophical ideas that resulted from images that appeared to him during the hypnagogic state. The mental activity at sleep onset can lead to hypnagogic hallucinations, resulting in either terrifying or creative experiences. It has been suggested that creativity and insight in sleep (compared to wakefulness) generally involve seeing information in new combinations and sequences, presented to consciousness (Broughton 1982). There have been cases where sleep (either nocturnal slumber or diurnal napping) has lead to the creation of musical or poetic compositions. Dreaming in sleep has solved problems, as in the case of at least two Nobel prizes. One was for discovering the elusive structure of the benzene molecule, which was in the form of a ring, in fact a hexagon, which August Kekulé visualized in his dream as a coiled snake. Another Nobel prize resulting from a dream was for Otto Loewi's experimental demonstration of neurochemical transmission via acetylcholine and involving epinephrine (adrenaline). If John Allan Hobson explains dreaming by microscopic disorientation and defines it as delirium, how do solutions to problems and insights appear to a dreamer?

Sleep "grogginess" or sleep inertia is the abnormal excessive confusion that can occur during the transition from sleep to wakefulness, a transition known as the sleep offset process (as opposed to sleep onset, i.e. the wakefulness to sleep transition). This sleep inertia is a natural altered state of consciousness, which requires further study. It is reported that sleep offset affects sleep inertia, which in turn affects mood behaviour. Moods can be positive or negative, depending on the amount of sleep and the moment of sleep offset (i.e. whether the subject is awakened from light, deep or REM sleep). Generally, if a subject is awakened from deep sleep, the sleep inertia is longer and greater. However, it is still unknown how mood is affected as a result of this prolonged sleep inertia.

The core function of sleep is unknown when tested under the null hypothesis. If the null hypothesis were correct, studies would be able to find that: there are animals that do not sleep at all; there are animals that do not need recovery sleep after a prolonged awake period; and the effects of sleep deprivation do not result in death. The nature of sleep is not universal across all known living species, but "sleep is present and strictly regulated in all animal species that have been carefully studies so far" (Cirelli and Tononi 2008, p. 1607). For some reptiles, amphibians and fish, scientific investigations suggest that they might simply rest instead of sleeping the way mammals and birds do. Flies' cerebral electrical activity is similar when awake and asleep to mammals. Bullfrogs' respiratory responses to stimuli suggest that they do not sleep, but more studies are needed to confirm this. Some coral reef fish sleep while they swim at night. However, there is no evidence to suggest that any species do not sleep at all. It is known that all terrestrial (excluding marine) mammals normally exhibit simultaneous electroencephalographic (EEG)

activity in both sides of the brain (left and right hemispheres). However, there are exceptions to this simultaneous EEG activity in both sides of the brain for humans, whales and dolphins. Bottlenose dolphins sleep by alternately turning off the left and right hemispheres of their brains. If the left side of their brain is asleep, the right is awake, and vice versa. This behaviour is known as unihemispheric sleep. The main reason for this hemispheric switching to regulate wake-sleep cycles in dolphins is that dolphins are constantly on the move in order to survive and protect their offspring from predators, such as sharks. This movement is unceasing from a dolphin's birth to its death. Humans are never consistently mobile and active (sleepwalking occurs in shorter episodes but is never continuous). More importantly, humans are never able to switch their brain sides in order to alternate their wake-sleep cycles. This may be one of the reasons for regarding dolphins as the most intelligent marine species. It remains unknown whether dolphins ever experience drowsiness.

Sleep has qualitative (intensity or depth) and quantitative (duration) measures. Humans and rodents experience the deepest sleep just after sleep onset. Humans experience sleep debt by staying awake for prolonged periods of time and then need a restorative sleep. This sleep debt reflects on the qualitative and quantitative measures of their sleep. While some people regularly need 8–10 h doses of sleep, others need fewer hours. The amount of sleep necessary for a human to function properly varies from one person to another. Studies have suggested that reducing regular sleep by a few hours can lead to significant risk of overall mortality. Studies on sleep-deprived rats have resulted in their death after 2–4 weeks. Death due to sleep deprivation was also evident in flies, cockroaches and humans. Humans can develop an extremely rare degenerative brain disease, called fatal familial insomnia. This disease, which prevents humans from falling asleep and maintaining a normal sleep, can last for several months and eventually leads to death. However, it is still not clear whether death is caused directly by sleep deprivation or indirectly by forced arousal, stress (associated with sleep deprivation), heart disease, stroke, diabetes, cancer, etc. One experiment revealed that a human can remain awake for 11 days. Unverified reports have claimed that some humans have remained awake for weeks and still functioned properly.

1.7 Meditation and Neuroplasticity

More research is required to characterise the nature of the differences among types of meditation. The phenomenological differences suggest that these various meditative states may be associated with different cerebral electrical activity or EEG oscillatory signatures. Much remains unknown about the meditation or mental training process and its impact on the brain. Some studies have recently linked meditation with plasticity of the brain or neuroplasticity. The term neuroplasticity is used in the neuroscience community to describe the ability of the neural network to change by growing new neurons or dendrites and synapses. Some fascinating studies have suggested that neuroplasticity can be enhanced under the mental

training of meditation (Berger et al. 2007; Poldrack 2002). Some of the studies report a progressive increase in theta and alpha EEG bands, where the transition from a neutral state to a meditative state requires 5–15 s (depending on the meditation subject) and is characterised by gamma EEG band synchronisation. Functional magnetic resonance imaging (fMRI) experiments were conducted on Buddhist monks in clinical settings and the results reveal that changes in the cortical evoked response to visual stimuli and amplitude and synchrony of gamma EEG band oscillations reflect the influence of various styles of meditation on attention. There are further suggestions that these changes in neural connectivity are triggered by the gamma EEG band synchronisation (Lutz et al. 2004).

1.8 Neural Correlates of Consciousness

Chalmers asked how one performs experiments to detect a correlation between some neural process and consciousness (Chalmers 1996, p. 115). Often, the main parameters of consciousness would consist of: focus of attention, subjective description of particular internal state, control of behaviour and even emotion. These parameters would then be correlated with any neural processes upon its activation or occurrence. The importance of studying the correlation between neural processes and parameters of consciousness is undisputed but the link between the psychology and conscious experience remains unknown.

Since the early 1990s, neuroscientists have been investigating synchronised gamma EEG activity (35–45 Hz) in relation to the binding problem. The activity may be related to conscious experience and seems able to bind certain functional information by synchronising the frequency and phase of the gamma waves carrying it. The binding problem is that of how different sensory input, such as colour, shape and location can be bound and experienced together as a single event. Functional information may include the matching of memory contents and perceptual contents, grouping of letters to form a word or words to form a sentence, learning, etc. The hypothesis is that information is bound and stored in working memory and finally integrated into the contents of consciousness. Two renowned neuroscientists, Francis Crick and Christof Koch, were the first to demonstrate the link between temporal binding and consciousness by bridging binding and sensory awareness (Crick and Koch 1990). Experiments show that gamma EEG activity is related to visual sensory binding. Evidently there is a mechanism that processes the functional information along a common synchronised pathway to generate the large functional states that underlie cognition. In other words, gamma EEG thalamocortical resonances are correlates of cognition. Similar research has revealed that the same 40 Hz waves of electromagnetic activity occur during wakefulness and dreaming (REM activity), despite the evident differences between these two states. The dreaming state may be described as “hyperattentiveness in which sensory input cannot address the machinery that generates conscious experience” (Llinas and Ribary 1993, p. 2081). This is one of a number of theories where

awareness has physiology and anatomy. Another study suggests that gamma EEG band synchrony may play a major role in the processes of visual consciousness (arousal, selective attention, working memory, etc.) and higher order consciousness (motivation, symbolic processing, action planning, etc.) (Engel and Singer 2001). The latter study revealed a single object response of gamma oscillatory synchronisation within and between visual cortical regions.

It is believed that subjective time is experienced as continuous. However, the neurophysiological processes that characterise consciousness are discontinuous in time (around the 80 ms epoch) and define a "travelling moment of perception" (Allport 1968). The significance of perception and what is actually perceived within our central nervous system can be explained by means of the illusions or tricks that out mind plays on us through our own sensory systems. For example, we perceive the flickering of lights at frequencies above 50–60 Hz as a steady light, and do so every day with our house lighting. As soon as the flicker frequency decreases, we begin to distinguish dark from light phases. This subjective visual sensation occurs somewhere below 50 Hz at a frequency called the critical fusion frequency. Similarly, our auditory sensation alters from a tone to an intermittent sound at 30–35 Hz (Wever and Lawrence 1954).

Tononi identified two properties of conscious experience: integration, or the inability to subdivide consciousness; and differentiation, the ability to select out of a wide range of different conscious states within a short time (Tononi 1998). In terms of integration of conscious experience, it is false to assume that certain local neurons or regions are more responsible for the occurrence of consciousness than other neurons. The general property of conscious experience is that the selection among integrated states must occur within few hundred ms in order to create a contemporaneous conscious experience. A group of neurons can influence conscious experience only if it can perform a certain functionality or task in less than a second. These groups of neurons may interact between posterior thalamocortical (associated with perceptual characterisation), anterior (associated with memory) and other regions. Tononi's claim contradicts the 1950s hypothesis by Wilder Penfield that stimulated brain structures outside or within the thalamocortical system, have no direct influence on conscious experience (Penfield 1958). Experimental findings indicate that in order to generate a conscious sensory experience, a high-frequency somatosensory (sensory modality for touch, temperature and pain) stimulus needs to be delivered to the thalamus for some 500 ms, and for at least 150 ms to trigger sensory detection without conscious awareness (Libet 1993). These times in ms allow a sufficient number of oscillatory cycles for synchronisation of the EEG activity. During the low-amplitude high-frequency EEG activity of the awake state and of REM sleep, the firing of neurons is not globally synchronous, which is consistent with reports of vivid dreams when awake. By contrast, people do not recall any vivid dreams or conscious experiences during deep sleep, characterised by high-amplitude low-frequency EEG activity, where neurons are synchronous and interactive in the thalamocortical system. Similar states of unconsciousness are generated during seizures, where neurons are highly interactive and synchronous across the whole brain and the subject becomes

unconscious. Such experimental evidence confirms that certain conscious experiences are correlated with alterations in neural activity that are driven by external or internal (images, dreams or memories) stimuli.

Our conscious experience of time is not generated by biophysical and biochemical neural processes alone. It is unknown how the human or animal perception of time is linked to experience and how that perception can be altered. The scientific focus has been to ask whether perception is continuous or segmented into episodes, as on an old film strip. Many visual illusions are part of our everyday experience. One such illusion is the "wagon wheel" effect where if a wheel is observed rotating at a certain speed, its spokes may be visually perceived as not moving or moving backwards. When this illusion was tested, it was found that when all subjects reported that the wheel was moving in the opposite direction, the EEG activity in their right inferior parietal lobe (associated with perception of visual location) was oscillating at 13 Hz. The results suggest that our visual information is processed in discrete frames and certainly not continuously. This frame-based visual perception may have to do with the brain processing different objects independently. Similar studies of visual perception showed that photic threshold stimuli are detected or perceived as theta and low alpha EEG phase responses (Busch et al. 2009). For the neural system to process sensory information in the auditory, visual or tactile modes, the information needs to be segmented into frames of 30–50 ms. Sensory information spread over longer than about 50 ms is not detected within one frame. Ernst Poppel described these frames as building blocks of consciousness. Other studies have revealed that if subjects are stimulated by a burst of auditory and visual tones and flashes, this may be perceived as a longer or shorter intermittent tone or flash. Reports also indicate that such auditory and visual stimuli may entrain gamma and other EEG activity, and that the faster the oscillations (in the gamma band), the more building blocks of consciousness or sensory perceptions are processed in our neural system.

1.9 Schizophrenia and Its Neural Correlates

Schizophrenic patients typically perceive time differently, suggesting that their internal clock might be altered. But what alters that internal clock in the first place? The term "schizophrenia" comes from the Greek language and means split mind. It was first recognised a century ago by a psychiatrist Eugene Bleuler, who described this mind splitting as a symptom of "erronous, irrational thinking and the inability to experience normal emotions" (Kidman 2007, p. 1). A split personality, where patients can turn into dangerous and violent people, is not a symptom of schizophrenia. Unfortunately, this is one of the social stigmas that has been associated with this illness for a long time. The primary symptoms (positive and negative) of schizophrenia include: hallucinations, hearing voices (one or more), seeing visions, having imaginary conversations and thoughts which command them to do things, hearing sounds and even music, having delusions (imagining that